WORKSHOPS

Nanotribology: Critical Assessment & Research Needs

President Clinton announced on Jan. 21, 2000, the launch of the National Nanotechnology Initiative (NNI). Nanotribology is a key subject area in nanotechnology. The workshop invited leading researchers from various specialties to address the research needs. The National Science Foundation (NSF), the National Institute of Standards and Technology (NIST), the Defense Advanced Research Project Agency (DARPA), the Sandia Laboratory, and the University of Maryland together are sponsoring this workshop to critically assess the current state-of-the-art of nanotribology within the context of MEMs, meso-manufacturing, nanotechnology, and microsystems. The goal is to identify gaps in current understanding and to recommend research areas that need to be addressed to enable the rapid development of the technologies.

Current advances in magnetic recording, MEMs, nanotechnology, meso-manufacturing, and microsystems technology all involve the basic issues of friction, wear, adhesion, and lubrication (Nanotribology). Micromachines and normal miniaturization demands also are pushing the scale of investigation of Nanotribology smaller and smaller. Many phenomena at small scales present different challenges in concept as well as practice. Because **Nanotribology** is a new field and the issues in each of the technology areas have different technical communities working on them, communication and exchange of ideas have been problematic. It is the purpose of this workshop to invite these communities to come together to discuss the common goal.

About 120 people from MEMs, Meso-manufacturing, and Tribology (universities, industry, and government labs) attended the three day workshop and a consensus research needs were identified. The proceedings will be published as a book containing the papers and recommendations.

LTCC Workshop 1: Low Temperature Co-Fired Ceramics; LTCC Workshop 2: Process Modeling of Laminated Multilayer Ceramic Systems; LTCC Roadmap

The rapid growth of portable wireless communication applications is driving demands for smaller size packaging and increased density of functions. Times to market are declining as well. One technology being developed to meet these challenges is Low Temperature Co-fired Ceramics (LTCC). However, in order to make this new technology economically competitive, there are measurement infrastructure issues that must be addressed. NIST and the Green TapeTM/LTCC Applications Group hosted a series of workshops to determine and set priorities for those generic measurement issues that NIST and industry can address together. Examples of such measurement needs include: inexpensive, reproducible dielectric measurements at frequencies above 1 GHz, modeling of tape processing, phase equilibria data for electrode/ceramic interactions, thermal property measurement procedures, etc. We invited material suppliers, component producers, and end users to this workshop, and used this opportunity to encourage open discussion among the participants regarding their measurements and technology infrastructure needs. Electronic packaging industry experts discussed and

prioritized material processing, physical property and electromagnetic measurement issues that NIST, the National Laboratories, academia, and the electronic packaging industry can collaboratively address, in order to accelerate adoption of LTCC technology for wireless applications.

Representatives from NIST, Dupont, CTS, etc. were invited to give prepared comments on opportunities being presented by the emergence of LTCC technology. Other electronics suppliers, researchers and OEMs such as Ericsson, Nokia, and Material suppliers, LTCC device producers, researchers and end users from industry, universities and government laboratories were invited to participate in the workshop. According to Dr. Sam Horowitz, marketing manager, Dupont Microcircuit Materials, and Dr. Dave Wilcox, Director of Advanced Technology, Motorola Labs, both founding members of the GreenTapeTM/LTCC Applications Group, "We have seen that the rapid growth of portable wireless communications applications is driving demand for lower cost, faster time to market, smaller sizes and increased density of functions in electronic packaging. LTCC materials are key to meeting these challenges… and we are pleased that NIST has agreed to lend its expertise to this important initiative." The Green Tape/LTCC Applications Group was organized to promote the greater use of LTCC multilayer ceramic integration technology in high volume wireless applications. The charter membership consists of electronic ceramic device (interconnect and module) manufacturers including CTS Corporation, Motorola, National Semiconductor, C-MAC-Scrantom Inc., Sorep, Vispro, and DuPont Microcircuit Materials.

Workshop on Texture in Electronic Applications

A workshop on texture in electronic materials, co-chaired by NIST, IBM and Ramtron Corporation, was held at NIST on October 10-11, 2000. The primary goal of the workshop was to provide a forum for the discussion of critical issues relevant to texture and texture measurement. Presentations covered a wide range of topics including production and control of texture in a variety of different device materials, various texture measurement techniques and analysis procedures, and effects of texture on properties and performance. A deliberate effort was made to engage participants involved in a broad array of materials, measurement techniques and application areas in order to provide an opportunity for meaningful interchange and collective insight into the measurement needs of the texture community. The nearly 40 attendees were evenly divided between industry, universities and national labs. During roundtable discussions, it became clear that there is a strong need for texture standards. A prerequisite for standards development is interlaboratory comparisons of results obtained on the same specimens with different techniques, and also on the same specimens using the same technique but different equipment. NIST agreed to take the lead in organizing such an activity, and will continue to design and validate texture measurement procedures for the specific needs of the texture community. A report on the Workshop will be published in the NIST Journal of Research.

Nonlinear Acoustics For Materials Characterization And Nondestructive Evaluation (NDE)

The event was held as part of the Review of Progress in Quantitative NDE conference (Ames, IA, 16-21 July 2000). The miniworkshop consisted of two four-hour sessions and was truly global in its makeup. The first session consisted of ten, twenty-minute contributed papers by researchers from Canada, Germany, Japan, Korea, and the US. The talks summarized ongoing research in a variety of areas including evaluation of bond adhesion and characterization of engineered surfaces. This session also included short question-and-answer periods.

The second session contained four invited, double-length talks from world leaders in nonlinear acoustic research: W.Arnold, Fraunhofer-Institute for Nondestructive Testing (Germany) Nonlinear effects in ultrasonic transmission of adhesive bonds: multiple and single contacts J. TenCate, Los Alamos National Laboratory (USA). New nonlinear acoustic techniques for NDE, T. Yost, NASA-Langley (USA) Nonlinear ultrasonic pulsed measurements and applications to metals processing and fatigue, I. Solodov, Moscow State University (Russia), Nonlinear interfaces and flaw detection in acoustic NDE. This session also included two half-hour periods devoted to open discussion. In these periods, general topics of current interest were explored by the audience and the speakers. The discussion periods were lively with spirited discussion on a variety of topics.

About 40-60 people attended each session (overall conference attendance was approximately 230). These sessions achieved their intended purposes, namely (1) to bring together researchers in nonlinear acoustics and (2) to inform the NDE community about current research in this area.

Reference Data and Reference Materials Needed for Biomaterials

Needs for reference data and biomaterials were identified at a NIST organized workshop held July 27, 2000. The 65 registrants from industry, NIH, FDA and academia joined with NIST staff in six concurrent breakout sessions that considered reference data needs in orthopaedic, cardiovascular, ophthalmologic, tissue-engineered, dental, and general biomaterials. Although the workshop was organized with the focus on reference data for biomaterials an over-arching conclusion from participants was the complimentary role of reference data and reference biomaterials in facilitating deployment of new health care delivery devices and for the development of national and international standards. Owing to the rapid pace of innovation the timely availability of reference data and reference biomaterials was deemed more critical to progress than completeness in most situations. In general, data on properties of interest included mechanical properties, surface and bulk physical and chemical properties, as well as biological and clinical responses to materials.

In addition to reference data, reference biomaterials for polymers, monomers, alloys, composites and ceramics were identified. The participants agreed that follow-up meetings should be held with the various constituencies for the purpose of exploring the formation of alliances to help meet the needs recognized in the workshop.

Metrology for Development of Embedded Capacitance Technology for High-Speed Electronics

MSEL scientists, in collaboration with industry and academia, are developing test methodology for embedded capacitance technology. There is a widespread need for power-ground decoupling in today's electronic circuits to assure signal integrity and to reduce electromagnetic noise. Currently used discrete capacitors pose several drawbacks, such as the significant manufacturing costs and the amount of surface area they occupy on the electronic assembly. In addition, discrete capacitors do not perform adequately at frequencies above 1 GHz, the frequency regime for today's wireless communication and other high-speed electronics. In looking for a technical solution the National Center for Manufacturing Science, NIST and more than a dozen industry partners formed a consortium to develop and advance embedded-decoupling-capacitance (EDC) technology. The embedded-decoupling capacitance appears to be the most efficient way to achieve low noise in the voltage driving device, and thus, the highest possible data-speed that otherwise is unobtainable by any other known packaging solution.

Through this multidisciplinary effort over the past two years, the EDC Consortium has identified polymer-ferroelectric-composite materials as one of the primary candidates for this new technology need. The MSEL effort focused on design of test vehicles and procedures for dielectric testing these polymer composite films. Progress on this effort was reviewed at a recent workshop organized by EDC Consortium that attracted over 100 researchers from materials suppliers, circuit manufacturers, original equipment manufacturers and universities. During the workshop experts from the Consortium members, including NIST, discussed new design guidelines and measurement aspects of the EDC test methodology that led to agreement on further actions towards developing a new standard test procedure for EDC technology**.**

National Dialogue on Combinatorial Methods for Materials Science

The National Institute of Standards and Technology and the Army Research Office co-sponsored a national dialogue on combinatorial materials science on May 31-June 1, 2000 to increase the level and productivity of public and private investments in combinatorial methodology for commercial and defense materials needs. Attended by 145 participants, this national dialogue drew participants from 48 companies, 17 universities, and 7 federal agencies and laboratories, and ranged from established practitioners to company and university researchers interested in adopting combinatorial methods to their internal R&D programs. Highlights of the conference include a set of keynote talks that focused on current combinatorial methodologies in the pharmaceutical and chemicals and materials industries, followed by structured sessions focused on each of the four stages of the combinatorial cycle: library production, library characterization and property assessment, informatics, and design of experiment and model development. An off-site 24 posters session provided an opportunity for engaged discussion and networking. Funding agencies such as NSF, ARO, and ATP discussed future funding opportunities in the area of combinatorial materials science. The workshop served as the launching platform for a continuing Technology Vision 2020 roadmapping workshop.

Dislocations 2000

Interest in the fundamentals of plastic deformation has been increasing dramatically over the past several years, in pure metals and alloys as well as in non-metallic systems. Much of the recent work involves exciting new approaches to this old problem including large-scale 3D atomistic and mesoscopic computer simulations, a variety of new experimental techniques, and the application of several modern statistical physics approaches. This work is occurring in many countries, but full international communication has been lacking. A focussed international conference will bring these diverse communities together.

Driven by the development of new theoretical, computational, and experimental techniques, the fundamental science of plastic deformation is undergoing a renaissance, just in time for the next century. Whereas the 20th century witnessed the development of dislocation theory, the 21st century should see the bridging of length and time scales from the atomic structure of dislocations to continuum plasticity. The Dislocations 2000 Conference is therefore occurring at a pivotal moment, and it will serve as a launching point for the next century of research in this field. The SCOPE of this conference is simply stated: fundamental research on dislocations in all types of materials and their role in plasticity.

Summer School on Neutron Small-Angle Scattering and Reflectometry

The NIST Center for Neutron Research (NCNR) held its sixth annual Summer School on Neutron Scattering at the Center on June 5-9, 2000. The course this year focused on the complementary techniques of small-angle neutron scattering (SANS) and neutron reflectometry (NR) and was intended to provide potential new users of these techniques with a basic understanding of the fundamental concepts and methodology along with training in the use of the SANS and NR facilities at the NCNR. An enthusiastic group of 32 graduate students and postdocs, predominantly from university chemical engineering and materials science departments, heard lectures by NCNR staff that were reinforced by demonstrations at the NCNR's two 30-m SANS instruments and two reflectometers and a tour of the entire facility. Partway through the week, the attendees were grouped into teams to acquire and analyze data on samples prepared by staff members to illustrate specific concepts covered in the lectures. Additional lectures on applications of the two techniques drawn from recent research in polymer science, complex fluids, magnetism, and structural biology were intermingled with the hands-on sessions at the instruments. The course closed with a session in which representatives from each team presented their experimental results to the whole class and staff, which prompted several lively discussions. Comments received throughout the week and on the course evaluation forms indicated that the course was successful in enabling the attendees to assess the applicability of neutron scattering to their own research interests.

As in the past, this summer school was jointly sponsored with the National Science Foundation, which provided financial assistance to many of the university participants. The NSF has recently renewed its commitment to support the NCNR's summer schools for an additional five years.